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THE

APPLICATION OF PHOTOGRAPHY

TO

MEDICAL SCIENCE,

INCLUDING A PROCESS FOR

PHOTOGRAPHING THE MICROSCOPIC FIELD.

BY
RANSFORD E. VAN GIESON, M.D.,
OF NEW YORK.

(Reprinted from the "New York Journal of Medicine" for January, 1860.)

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THERE is, perhaps, no art that has made such rapid strides, even in this, the most progressive of all centuries, as that of photography. The most profound philosophers of this age have studied and elaborated it as a science, while thousands are daily practicing it as an art. No single branch of art of its age is so universal; no science of modern times has more engaged the attention of philosophic investigators. The history of this truly beautiful science, though extremely interesting, would be inappropriate in a paper of this kind, the object of which is more to show the advantages of the cultivation of the art and its application to medical science, than to enlarge upon its beauties, or to pen the details of its rise and progress. The majority of medical men are so busied in their daily professional duties, that they would, perhaps, deem it a waste of time to engage themselves in a study of this kind, which upon cursory examination appears to have no immediate connection with medicine. And yet there is no science or art not strictly medical, the cultivation of which will more richly repay the *scientific* physician.

To the practical demonstrator, photography is invaluable. By it he can secure accurate representations of anatomical specimens, which for faithful delineation, far surpass the most trustworthy engravings. By it the pathologist can fix upon paper the most rare and curious specimens of disease. By it the surgeon will be enabled to present the exact appearance of the deformity in any given fracture, dislocation, or any external surgical lesion whatever. The advantage which would result from the establishment of photographic departments in our various charitable institutions, can scarcely be over-estimated. We are not aware, however, that anything of this kind has, as yet been attempted. If we consider for a moment the vast amount of material furnished by Bellevue and the City Hospital alone, we must admit that such a valuable adjunct to medical instruction, if properly conducted, would, in the course of

time, result in great benefit to the profession at large. It is principally in our hospitals that the most abundant opportunity is offered for pathological research ; here it is that the most rare and striking cases of surgical deformity present themselves. These alone, to say nothing of skin diseases, would furnish material enough to form a valuable series of photographic plates, which would adorn the walls of the above institutions with as much propriety, and certainly with more benefit, than the portraits of our veteran surgeons, or the melancholy remembrancers of departed walkers. While endeavoring to demonstrate the practicability of some of the foregoing ideas, it occurred to us, that photography might be made subservient to medicine in still another manner. Every one who has been much in the habit of using the microscope, must occasionally have longed to fix upon paper some exquisitely perfect and rare specimens of microscopic anatomy or pathology, which now and then present themselves in the field, and regretted that no more perfect instrument was obtainable, than the camera lucida.

Again, it must be apparent to every one engaged in studies of this kind, that many of the microscopic representations, seen in books, are frequently exaggerated or faulty in detail. Indeed, with our present means, such must necessarily be the case. What we desire is the *exact* representation of the field ; this, it will be admitted, is an object impossible to be attained even by the most skillful manipulator with the camera lucida. The only manner then, by which an *exact* and *perfect* representation of the field can be secured is by means of *photography*.

Attempts have been made, both in France and England, to secure this object, but we are not aware that any *practical* method has ever been presented to the public. In a criticism upon one of the latest works on the microscope, "The Application of the Microscope to Practical Medicine," by Dr. Beale, we find the following sentence : "But the quality which more than any other, in our opinion, renders this book of great value, is the large number of wood cuts, 271, representing for the most part microscopical appearances, observed and *drawn* by the author himself." This would not seem to imply that microscopical photography has made much progress in England ; else Dr. Beale would certainly have availed himself of the advantages which it possesses over the tedious manipulation with the camera lucida. Again, to be able to delineate the field by means of this instrument, even with tolerable accuracy, requires an artistic skill which can only be obtained by long practice and repeated failures. The first attempts strongly reminded us of our youthful endeavors to draw with the transparent slate ;

when we supposed we had finished, and removed the glass to inspect our efforts, we discovered a horse minus the head, houses with smoke issuing from invisible chimneys, trees without trunks, &c. So it is, to some extent, with the first attempts at microscopical drawing; when we suppose the field is completed, we are astonished to find here a cell without a nucleus, there a nucleus with no cell wall. That the process is both tedious and extremely trying to the eye, any one who has ever attempted it, will readily admit. Again, the present method is tiresomely slow, and undeniably inaccurate when finished. The almost irresistible inclination to *embellish* and *improve* the original draft, which few even of our most truthful observers can combat, will account to some extent for this latter fault.

In what manner, then, can we avoid these difficulties? This question admits of but one answer—combine the *camera* and the *microscope*. If we bear in mind that any object which is capable of being impressed upon the sensitive retina, can as well be cast upon the *sensitive* plate of the *photographer*, we shall encounter but little difficulty in accomplishing our object. The rays of light which emanate from a *microscopical* object, if powerful enough to produce an image upon the *retina*, can with a little ingenuity, be increased in chemical power so as to produce the same image upon a sensitized plate. The microscope, in fact, is a camera; the retina, the ground glass plate upon which the object is received, and the retentive brain the sensitive medium upon which the image is indelibly fixed. Convinced of the truthfulness of the above theories, we instituted a series of experiments while yet at college, in order to demonstrate their practicability. Our researches were abruptly terminated by the winter course of lectures, and the preparation for the various examinations through which the humble aspirant for a medical degree must honorably pass. The proverbial abundance of time, and the absence of any very onerous professional duties in the first few months of a young physician's practice, permit us now to present the matter to the consideration of the public. Being already, to some extent, familiar with photography in all its details, one great source of difficulty was removed. Our first attempts resulted, of course, in a series of discouraging failures; but as each failure tended to simplify the process, we were stimulated to continue our experiments, until finally the object was attained. The whole instrument is now sufficiently simplified to be understood by the merest tyro in optics. The only microscope at our command was one of Chevalier's manufacture, with a power of two hundred and fifty diameters. To the main tube of this instrument a closely-fitting *slide* with a *flange*, about three-fourths of an

inch in diameter, was attached. This slide and flange occupies about two-thirds of the whole length of the main tube; upon the remaining third a slide and cap is attached in order to hold the object. The whole apparatus is then, by means of the flange, adjusted to the ordinary camera-box. A diagram will illustrate this simple combination so that no one can fail to comprehend it:

Fig. 1.

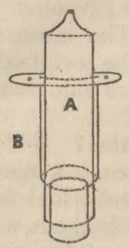


Fig. 2.

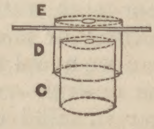
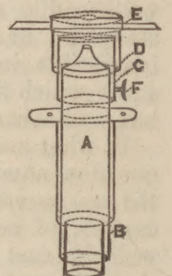


Fig 3.



A is the main tube of the microscope; *B* represents the slide and flange by which the whole apparatus is attached to the camera-box. Upon the remaining third, containing the object glass, the slide and cap is fitted. *C*, figure 2, represents the slide over which the cap *D* is adjusted; at *E* the cap is perforated by a small slot in which the glass, containing the object to be photographed, is placed. After the object is secured by pressing down the cap, it is adjusted to the microscope. *Figure* 3 represents the instrument when ready to be attached to the camera-box. To the slide *C* a gear wheel and ratchet *F* with a fine feed is affixed, by which the exact focus may be secured.

Fig. 4.

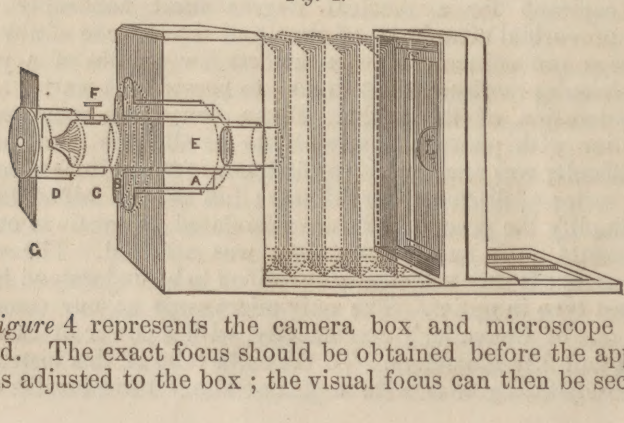


Figure 4 represents the camera box and microscope combined. The exact focus should be obtained before the apparatus is adjusted to the box; the visual focus can then be secured

by moving the ground glass plate by means of the bellows extension. In order to see the object distinctly upon the ground glass the camera must be pointed directly towards the sun, so that the central rays may strike the object. After the focus is obtained, the ground glass is removed, and the iodized or sensitive plate, upon which the image is to be fixed, substituted.

It will be perceived, that the instrument differs in no material respect from the ordinary camera, except that in one case the object is within a sixty-fourth of an inch from the lens, while in common photographing it is several feet from it. In taking an ordinary picture, the aperture in the tube containing the lenses, is sufficiently large to admit of an impression being taken by diffused light; but with what might be called the *microscopic camera*, the opening is so small, that we are obliged to use the *direct* rays of the sun. For every increase in diameter, there will be a corresponding *decrease* in the brightness of the image upon the ground glass. In an instrument of over four hundred diameters, a condensing lens, to concentrate the rays of the sun upon the object, will frequently be found necessary. Care must be taken not to converge the rays upon the object *too much*, else the heat generated, will crack the glass containing the object, and ruin the specimen. An ordinary stand upon which to place the camera, so as to direct the object towards the sun, though not so convenient as a stout iron apparatus, with a movable joint, can, by a little contrivance, be made to answer every purpose.

Having thus given, as briefly as possible, the general outlines of the method of combining the microscope and the camera, we will now proceed to the details of the most important and difficult portion of our work, viz., that of taking what photographers call a *negative;* and inasmuch as many in whose hands this paper may fall, may be totally unacquainted with photographic manipulation, we will, in the course of the article, make use of such explanatory remarks as will render the process both easy of comprehension and execution. We will give, first, a complete list of the apparatus and chemicals needed in the process.

Apparatus for the negative process.—

Camera box and holder ¼ size.
Support for camera.
Gutta percha bath and dipper, 12 to 16 oz.
" " dishes for hyposulphite.
Glass stoppered bottle for collodion, 4-8 oz.
Common 16 oz. bottle for developer.
Photographic holder, to retain the negative in contact with the paper.
Two or three funnels.
Two pails; one with a faucet.
Hand vise to hold plate while cleaning.

Chemicals.—Nitrate of silver in crystals; Acetic acid; Iodide of potassium; Sulphate of iron; Chloride of gold; Aqua Ammoniæ; *Photographic* paper; Prepared collodion*; Filtering paper; Cotton Batting; Pulverized rotten stone; Negative Varnish.

Having obtained the foregoing articles, we are prepared to commence operations. Before proceeding farther, we cannot forbear recommending that every article should have a *certain place*, and furthermore, that everything should be kept perfectly clean. Order and cleanliness, even with but a limited amount of knowledge, will often ensure success, while on the other hand, disorder and carelessness, with the best apparatus and chemicals, cannot but lead to unfavorable results; medically speaking, photography and carelessness are incompatible. One article has been intentionally omitted in the foregoing list, inasmuch as it belongs neither to the apparatus, nor to the chemicals, but is an attribute that should preponderate largely in those who wish to pursue microscopic photography, and that is *patience.*

An attempt to *hurry* any particular part of the process, will invariably be attended by mortifying failures.

The process may be divided into *thirteen parts*, *eight* of which pertain to the taking of the negative, and *five* to obtaining an impression upon paper. Those processes marked by an asterisk, must be conducted in the dark chamber.

Formation of the bath.	Fixing the image.
" " " developer.	Formation of Ammonia nitrate.
Cleaning the plate.	Salting the paper.
Iodizing " "	* Sensitizing the paper.
* Dipping " "	Printing.
Exposing " "	Fixing and Toning.
* Developing the image.	

Formation of the bath.—Take of water (distilled) 16 oz.
" nitrate of silver, $1\frac{1}{2}$ oz.
To 6 ounces of the water add the whole of the nitrate.

Shake well, and add three grains of iodide of potassium, dissolved in a small portion of water; when the resulting iodide of silver is to some extent taken up, add the remaining ten ounces of water, together with eight or ten drops of acetic acid, No. 8, or just enough to give a faint acid reaction to the solution. Let the bath stand for about an hour and a half, then filter *perfectly clear*, and it is ready for use.

The object of adding iodide of potassium to the bath is to prevent the nitrate from dissolving the iodide of silver off the sensitive plate. Acetic acid is added, in order to prevent the

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* We have obtained excellent results with the negative collodion of Messrs. Lewis & Holt.

too rapid action of light upon the plate. It also retards the action of the developer, thereby preventing what is termed "fogging," or a dusky, dim appearance of the image.

Formation of the developer.—Take of sulphate of iron (pure) 1 ounce.

Water,	16	"
Alcohol,	1	"
Acetic acid,	3	"

Dissolve the sulphate of iron in the water ; add the alcohol and acetic acid, and filter perfectly clear.

Cleaning the plate.—Fasten the plate in the hand vise ; pour on a mixture of pulverized rotten stone and alcohol ; rub thoroughly with a piece of canton flannel ; then finish with three or four strips of the same material, until the plate is perfectly clean.

Iodizing the Plate.—When the plate is perfectly clean, it is ready for the application of the collodion. In doing this, hold the plate as nearly level as possible, pouring the collodion upon the middle of the glass ; when the surface is covered, elevate the plate, and let the surplus collodion drain back into the bottle from the lowermost right hand corner. When the collodion becomes somewhat glutinous, the plate must be steadily and quickly lowered into the bath. It is somewhat difficult to give any precise directions regarding the time when the plate should be dipped. As a general rule, it ought to be immersed just when the collodion ceases to stick to the finger when applied to one of the upper corners of the plate. Should the plate be dipped too soon, the chemical decomposition between the bromides and iodides in the collodion and the nitrate in the bath, will not readily take place. Should the surface be allowed to become too dry, the coating of iodide and bromide of silver formed in the bath will be inclined to be granular, and easily washed off by subsequent manipulation. After the plate has remained in the bath from three to six minutes (during which the object can be focused), the plate may be inspected by drawing it gently up to the surface of the nitrate ; if covered by a clean white coating, it may be removed ; if it has a greasy appearance, it denotes that the formation of the bromo-iodide of silver is not yet complete, and should therefore be allowed to remain some time longer. When the plate is completely coated, it is placed in the holder, and carried to the camera, care being taken to keep it *perpendicular*, so as to prevent the nitrate of silver from flowing irregularly over the plate.

Time of Exposure.—This will vary according to the transparency of the object and the power used. With a power ranging from 140 to 250 diameters, from 10 to 16 seconds will be

required to produce a negative of sufficient intensity to print a good photograph; with higher powers, the time of exposure must of course be proportionately longer.

Developing.—It is chiefly in this part of the process that the experimenter will meet with the most pleasure and at the same time difficulty. Pleasure, because there is something peculiarly fascinating in beholding the lifeless plate becoming in an instant, under the magic influence of the developer, as it were, replete with vitality. The surface which before exhibited not the slightest trace of an image, now reveals the object in all its details. It grows under our very gaze; we seem for the time being to be possessed of a power almost creative; nor does this peculiar fascination ever become completely exhausted; the most experienced photographer will inform you that he never approaches this part of the process without a feeling of mingled curiosity and dread. The developer, if properly used, tells us in an instant if our previous manipulation has been correctly conducted; if not, it reveals the fault and its remedy. The *difficulty* that attends this part of the process, may be overcome by a cautious *application* and a judicious *removal* of the developing fluid. The developer should be *applied* as follows:

Take the exposed plate by one corner, hold it as nearly level as possible, and *flow* it so as to cover the whole surface *evenly* and *quickly*. Any attempt to *pour* the developer upon the plate will certainly spoil the image. The next question is, at what time must the developer be removed? This will depend almost entirely upon the time of exposure; *cæteris paribus*, the *longer* the exposure, the *shorter* the development; the *shorter* the time of exposure, the *longer* the development. The chief question, however is, at what time, after the *image* has shown itself, shall the developer be removed? This again, will depend upon the *intensity* that we desire to produce. If we wish a negative that will print very slowly, the development must be carried as far as possible; if, on the contrary, we wish a negative that will print *rapidly*, we must of course cut short the development as *soon* as possible. It will readily be seen by the chemist, that developing is neither more nor less than a reduction of metallic silver upon the parts that have been exposed to light. Of course where the light has been most intense, just there will the chemical decomposition be most energetic; it necessarily follows that the greater the deposition, the more will the light of the sun be obstructed in printing from the finished negative upon paper. The term intensity, as used in photography, has reference to the *thickness* of the silver coat. When the sun's rays are much obstructed by this latter, the negative is said to be of great *intensity*. The best negatives are secured

when there has been a *medium* exposure and development. If the exposure has been properly timed, the developer should be removed when the outlines of the whole image are strongly marked ; still, the experimenter unaccustomed to photographic details will be liable to make several failures before he will be enabled to judiciously combine the exposure and development. If, after a negative is finished, we find it to be too intense to print well, it would be advisable in the next trial, to diminish both the time of exposure and development. Should the picture assume the appearance of an ordinary *positive* (where the image is backed with black varnish, and viewed by *reflected* light) both the exposure and development should be prolonged. A few experiments conducted in this manner will ensure final success. When the operator has reason to believe that the development has reached its maximum, he should place the plate under the pail containing pure water, turn on the stop-cock, and let the water flow gently over the image, until all traces of sulphate of iron have been removed. The picture is then ready for what the photographers term "*fixing*," or in other words, dissolving off the undecomposed bromo-iodide of silver. This, of course, can be done by dipping the plate into a solution of any salt, which is capable of holding in solution a bromo-iodide. Of these there are many. For photographic purposes, however, a solution of the hyposulphite of soda is preferable, in as much as it acts more slowly and evenly than the cyanide of potassium, which is used for positive pictures.

Fixing Solution.—Hyposulphite of soda, two ounces ; water, sixteen ounces.

The negative is left in the fixing solution until the image is seen clearly by transmitted light ; if left in too long, the picture will become gradually darkened. The solution, however, works so slowly, that nothing but culpable negligence will spoil a negative which has been properly developed. When the whole of the undecomposed bromo-iodide of silver has been dissolved off, the plate is placed under the cleansing pail, and all traces of hyposulphite of soda washed away. There is but little danger of destroying the image by washing *too long;* on the other hand, if the plate is not thoroughly cleansed, some hyposulphite of soda will remain, which will, in the course of time, slowly but surely cause the picture to fade. When the plate has been cleansed, and cautiously dried, over an alcoholic flame, it is ready for the negative varnish, which prevents the image from being defaced by subsequent printing. The varnish is applied in the same manner as the collodion, care being taken that no particles of dust or dirt are included, each one of which, by obstructing the sun's rays, will form a white speck upon the paper positive.

The operator being now supplied with a good negative, is prepared to transfer the image to paper. The *printing* process may be conveniently divided into five parts, viz.:

Formation of
1. Ammonio-nitrate of silver.
2. Salting the paper.
3. Sensitizing "
4. Printing.
5. { Fixing, Toning.

Formation of the Ammonio-nitrate of silver.—Take of crystallized nitrate of silver, 100 grains; water, 2 ounces, dissolve the nitrate in the water; pour off one half ounce of the solution; to this add very cautiously drop by drop, liquor ammoniæ until the oxide, which is first formed is just dissolved. When this takes place, add the remaining ounce and a half of the silver solution, and filter perfectly clear. Inasmuch as the ammonio-nitrate is very sensitive to light, it should be kept in a bottle of black glass so as to prevent decomposition. It is important that care should be exercised in adding the ammonia, for if an undue proportion is present in the solution, the chloride of silver subsequently formed will be dissolved, and the sensitiveness of the paper greatly impaired.

Salting the paper.—The paper is salted by means of some soluble chloride, usually either chloride of ammonium or sodium; chloride of ammonium, is generally preferred.

Salting solution.

Chloride of Ammonium	24 grains.
Water	12 ounces.
Loaf sugar	6 grains.

When the ingredients are perfectly dissolved, immerse the paper in the solution; after the surface is thoroughly covered, it may be removed, and pinned up to dry. When dry, it is prepared for the application of the ammonia nitrate of silver, which is laid on by means of a fine camel's hair brush, or what is better, a bit of cotton batting tied upon the end of a stick. Care should be taken to draw the brush evenly over the paper, going over it both lengthwise and crosswise, so that the whole surface may be covered. When the slips of paper have become dry, they are ready for printing.

The slips of paper should, if possible, be sensitized in the evening by artificial light; this saves the trouble of operating in the dark room. Only a few slips should be made sensitive at one time, inasmuch as they are liable in the course of twelve or fifteen hours, to become of a yellow hue, the result of partial decomposition.

Printing.—Place the paper, sensitive side upwards, upon some soft medium like canton flannel; upon the paper apply the negative, *collodion-side* downwards; fasten the whole to a level piece of board, by means of spring clothes pins, and expose it to the direct rays of the sun. When the paper which projects from beneath the plate has turned to a deep bluish black, the picture (provided the negative is of the proper intensity) is ready for "*fixing* and *toning*." This latter process is absolutely necessary. The paper must be *fixed*, in order to prevent the portions unacted upon by the light from eventually becoming as dark as the image, and "toned," that the picture may assume a fresh, lively appearance.

Both the toning and fixing are usually accomplished in the same bath, which consists of hyposulphite of soda, in excess, to dissolve the undecomposed oxide, nitrate, and chloride of silver. A small quantity of chloride of gold is added, from which a thin film of metal is deposited upon the image, giving what photographers call the "tone." We have not been able to make the toning bath prepared from the ordinary formula, produce as good results as the following:

Chloride of gold	6	grains.
Nitrate of silver	25	"
Hyposulphite of soda	2	ounces.
Water	6	"

Dissolve the hyposulphite of soda in three ounces of water, the chloride of gold in two ounces, and the nitrate of silver in the remaining ounce; to the solution of hyposulphite of soda, add very cautiously, little by little, the chloride of gold, stirring constantly while mixing; then add in the same cautious manner the nitrate of silver; let the whole stand for a few hours, and the bath is ready for use. It is highly important that the *order* of mixing the solutions here given, should be strictly observed. If the *hyposulphite of soda* is poured into the chloride of gold solution, a precipitation of *metallic gold* will ensue, a result by no means desirable. If the order of mixture is rigidly followed, a double hyposulphite of soda and gold is formed, from which salt the film of metal is deposited upon the image. The toning bath differs in this from the rest of the chemicals employed in photography, that it *improves* with *age*. The experimenter should not therefore be discouraged, if his first attempts in toning and fixing are not successful; after a few prints have been immersed, a decided improvement will gradually manifest itself.

The *time* that a print must remain in the bath, will depend to a certain degree upon the fancy of the operator. It is ad-

visable, however, to remove it, when a light bluish-black tint shows itself, or nearly the color the print possessed, when first immersed ; this will require from one hour and a half to four hours, depending upon the original tint of the print and the temperature. Up to a certain point, the longer a print remains in the bath, the blacker does it become ; it should not, however, be allowed to remain *too long* with the hope of increasing the black, where the printing has been improperly conducted. A mistake made in *printing*, cannot be rectified in *toning*. By remembering this, much trouble and many failures may be avoided. After the print has been removed from the bath, it should be washed for a few moments under a running stream, and allowed to remain in pure water until all traces of hyposulphite are completely removed. This will require from three to five hours. By tasting of one corner of the print from time to time, we can ascertain with sufficient accuracy, if the washing is complete. The paper, when first taken from the bath, possesses an intensely sweet taste. When this saccharine taste becomes imperceptible, the print is considered sufficiently cleansed. The picture is then placed between two folds of bibulous paper, to remove superfluous moisture, pinned up in the sun, and allowed to dry. It is then ready for mounting, as the experimenter sees fit. It is not presumed that the operator will obtain a perfect representation of the field in his first trials ; for the reason that a certain amount of preliminary *practice* is needed, even with the most explicit and voluminous directions. Each failure, however, reveals to the intelligent experimenter its *cause*, and how it can be in future avoided. It should be remembered by the beginner, that the great causes of failure are :

Over-exposure = fogging.
Over-developing = "
Under-exposure = want of intensity.
Under-development = " " "
Dirt in the bath = streaks.
Dirt in the collodion } = opaque and transparent spots.
Dirt in the developer }

By the foregoing process, which is the result of our own experience in this somewhat novel department of photography, we have been enabled to arrive at a degree of success far beyond our most sanguine expectations ; we therefore offer it to the profession, brief and necessarily incomplete as it is, with confidence, feeling assured, that if the directions and suggestions here given are followed, success will ultimately reward their efforts. It was not our intention, nor have we endeavored to enlarge upon the photographic details inseparately

connected with the process. Only such directions are given, as were deemed *absolutely* necessary. Our aim in so doing, was, if possible, to save the experimenter the labor of wading through some one of the thousand works published upon this subject. For those who are unacquainted with the *chemical* laws connected with the action of light upon the salts of silver, we would recommend Hardwich's *Photographic Chemistry*, a book not valuable because of its formulas, but eminently fitted to give both theoretical and practical information upon this intricate subject. I am indebted to my associate, Dr. Charles F. J. Lehlbach, for the following comparative remarks upon the process of M. Donné, which are somewhat interesting in this connection:

M. Donné, in his work on microscopic anatomy* refers to his apparatus—" microscope photo-electrique "—and mentions that a number of the plates of the splendid atlas accompanying the book, were obtained from daguerreotypes taken by its means. It must not, however, be supposed that these plates were *directly* obtained by a combination of the microscope and the camera. They were copied from the daguerreotype, and thus liable to the exaggeration and faults of the engraver not only, but also of the copyist. But however this may be, the reader can best satisfy himself as to the insufficiency of Donné's and Foucault's apparatus, by referring to Pouillet's " *Elements de Physique experimentale et de la Meterologie*," 5th edition. Vol. II.; Paris, 1847, p. 422, where a description and plates of the apparatus are given.

In Donné and Foucault's photo-electric microscope, the light of charcoal, rendered strongly incandescent, by means of a Bunsen electric battery of sixty plates, is thrown upon a reflecting mirror, whence it passes through a screen, consisting of an oblong glass box, containing a solution of alum, in order to absorb the caloric; thence the light is thrown upon the object to be examined, which is placed in the focus of a series of lenses, representing an ordinary solar microscope, behind which another screen is placed, upon which the picture is caught and fixed.

M. Donné's method, then, is not one by photography, as this term is *now* understood (printing and multiplying pictures from a collodion negative) but simply photography by the primitive and long known process. By Donné's process, the image of the microscopical field cannot be fixed directly upon wood or stone, ready for the engraver, but has to be copied; its advantage, hence, consists chiefly, in giving the draftsman a permanent pic-

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* *Cours de Microscopie Complémentaire des Études Médicales*, etc., with Atlas.

ture of the field, while it does not dispense with his services altogether. Besides this, Donné's apparatus is so *complex*, *difficult of manipulation*, and *expensive*, that, as experience has amply shown, it can never be of general practical value to the scientific public.